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VERIFICATION OF TRANSLATION

I, Kiyonori ISHIKAWA of Ark Mori Building, 13F, 12-32, Akasaka 1-chome, Minato-ku, Tokyo 107-6013, Japan, do hereby certify that I am conversant with the English and Japanese languages and I am a competent translator thereof, and I further certify that to the best of my knowledge and belief the following is a true and correct English translation made by me of the Priority Document No. 2003-033231 filed on February 12, 2003 attached hereto.

Signed this 9th day of March, 2006

Kiyonori ISHIKAWA

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[Article]	Abstract	1

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[Title of the Invention] ANTI-THEFT APPARATUS, ANTI-THEFT METHOD AND ANTI-THIFT PROGRAM

[Claims]

[Claim 1] An anti-theft apparatus mounted on a vehicle for detecting acceleration in a predetermined direction comprising:

an acceleration detection unit whose detection result in a first detection sensitivity is used for a predetermined vehicle control;

a sensitivity switching unit for switching the detection sensitivity of said acceleration detection unit to a second detection sensitivity which is different from said first detection sensitivity when it received an anti-theft instruction for instructing prevention of theft; and

a theft judgment unit for judging whether or not said vehicle is in a theft state on the basis of the detection result of said acceleration detection unit which was switched to said second detection sensitivity by said sensitivity switching unit.

[Claim 2] The anti-theft apparatus as set forth in claim 1, wherein said sensitivity switching unit switches respective detection sensitivities of a plurality of acceleration detection units which are mounted on said vehicle when it receives said anti-theft instruction, and

said theft judgment unit judges whether or not said vehicle

is in the theft state on the basis of respective detection results of said plurality of acceleration detection units.

[Claim 3] The anti-theft apparatus as set forth in claim 2, wherein said theft judgment unit judges that said vehicle is in the theft state, in case that acceleration which was detected by any one of acceleration detection units out of said plurality of acceleration detection units exceeds a predetermined threshold value.

[Claim 4] The anti-theft apparatus as set forth in claim 2, wherein said theft judgment unit judges that said vehicle is in the theft state, in case that respective accelerations which were detected by a plurality of acceleration detection units for detecting acceleration in the same direction out of said plurality of acceleration detection units exceed a predetermined threshold value.

[Claim 5] The anti-theft apparatus as set forth in any one of claims 1 to 4, wherein said theft judgment unit judges whether or not said vehicle is in the theft state on the basis of inclination of said vehicle.

[Claim 6] The anti-theft apparatus as set forth in any one of claims 1 to 4, wherein said theft judgment unit judges whether or not said vehicle is in the theft state on the basis of vibration of said vehicle.

[Claim 7] The anti-theft apparatus as set forth in claim 6, wherein said theft judgment unit judges whether or not said

vehicle is in the theft state on the basis of a detection result of an acceleration detection unit which was disposed at an outer edge part of said vehicle..

[Claim 8] The anti-theft apparatus as set forth in claim 6, wherein said sensitivity switching unit switches each detection sensitivity in such a manner that said second detection sensitivity of the acceleration detection unit which was disposed at a central part of said vehicle becomes higher than said second detection sensitivity of the acceleration detection unit which was disposed at the outer edge part of said vehicle.

[Claim 9] The anti-theft apparatus as set forth in any one of claims 1 to 8, wherein said acceleration detection unit is an acceleration sensor which was disposed in a front collision air bag ECU, an acceleration sensor which was disposed in a side collision air bag ECU, an acceleration sensor which is used for electronic control suspension and/or an acceleration sensor which is used for a vehicle stability control system.

[Claim 10] The anti-theft apparatus as set forth in any one of claims 1 to 9, further comprising a noise elimination unit for eliminating noise from the detection result of said acceleration detection unit, and

wherein said theft judgment unit judges whether or not said vehicle is in the theft state on the basis of the detection result from which noise was eliminated by said noise elimination unit.

[Claim 11] The anti-theft apparatus as set forth in claim 10, wherein said noise elimination unit eliminates said noise by switching a cutoff frequency of a filter which is additionally disposed in said acceleration detection unit to a frequency which corresponded to theft judgment of said vehicle.

[Claim 12] The anti-theft apparatus as set forth in claim 10, wherein said noise elimination unit eliminates said noise, by periodically integrating the detection result of said acceleration detection unit.

[Claim 13] The anti-theft apparatus as set forth in claim 10, wherein said noise elimination unit eliminates said noise by switching a cutoff frequency of a filter which is additionally disposed in said acceleration detection unit to a frequency which corresponded to theft judgment of said vehicle, and by periodically integrating the detection result of said acceleration detection unit.

[Claim 14] The anti-theft apparatus as set forth in any one of claims 1 to 13, wherein said acceleration detection unit is contained in a predetermined unit together with various devices, and power is supplied thereto from a battery which was mounted on said vehicle or a dry battery which was contained in said predetermined unit, in the same manner as in said various devices, and

further comprising a power supply control unit for controlling said power source only to said acceleration detection

unit in said predetermined unit, and

wherein said theft judgment unit judges whether or not said vehicle is in the theft state on the basis of the detection result of said acceleration detection unit which was controlled so as to supply said power source by said power supply control unit.

[Claim 15] The anti-theft apparatus as set forth in Claim 14, wherein said power supply control unit controls so as to intermittently supply said power source from said battery or dry battery to said acceleration detection unit.

[Claim 16] The anti-theft apparatus as set forth in claim 14 or 15, wherein said power supply control unit controls so as to stop supply of said power source to said acceleration detection unit, in case that a voltage of said battery or dry battery became a predetermined voltage and below.

[Claim 17] The anti-theft apparatus as set forth in any one of claims 1 to 16, further comprising a monitoring unit for monitoring a state of said vehicle and for sending out said anti-theft instruction, and

wherein said sensitivity switching unit switches detection sensitivity of said acceleration detection unit to detection sensitivity which is available for theft judgment of said vehicle, when it receives the anti-theft instruction which was sent out by said monitoring unit.

[Claim 18] The anti-theft apparatus as set forth in claim

17, wherein said monitoring unit monitors an ON-OFF state of an ignition key, and sends out said anti-theft instruction, in case that said ignition key was turned to the OFF state.

[Claim 19] Anti-theft method comprising:

an acceleration detection step of detecting acceleration in a predetermined direction, a result of said detection in a first detection sensitivity being used for a predetermined vehicle control;

a sensitivity switching unit of switching the detection sensitivity of said acceleration detection step to a second detection sensitivity which is different from said first detection sensitivity when an anti-theft instruction for instructing prevention of theft was received; and

a theft judgment step of judging whether or not said vehicle is in a theft state on the basis of the detection result of said acceleration detection step which was switched to said second detection sensitivity by said sensitivity switching step.

[Claim 20] A anti-theft program for having a computer executed

an acceleration detection step of detecting acceleration in a predetermined direction, a result of said detection in a first detection sensitivity being used for a predetermined vehicle control;

a sensitivity switching unit of switching the detection sensitivity of said acceleration detection step to a second

detection sensitivity which is different from said first detection sensitivity when an anti-theft instruction for instructing prevention of theft was received; and

a theft judgment step of judging whether or not said vehicle is in a theft state on the basis of the detection result of said acceleration detection step which was switched to said second detection sensitivity by said sensitivity switching step.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

This invention relates to an anti-theft apparatus, an anti-theft method and an anti-theft program which can surely detect a theft state of a vehicle, such as inclination and vibration of a vehicle due to a theft action, even in a case that various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are also used for anti-theft.

[0002]

[Related Art]

In the past, in a vehicle such as an automobile, an auto-bicycle and so on, in order to prevent theft of a parked vehicle and a tire by use of jack-up and so on, there was such a case of mounting anti-theft dedicated ECU (electronic control unit) in which an inclination sensor was incorporated. Further, in recent years, for the purpose of reducing a cost, there has

been such a proposal that the anti-theft dedicated ECU is not mounted, but an acceleration sensor inherently mounted on a vehicle for an application other than anti-theft is also used for an application of anti-theft.

[0003]

For example, in a JP-A-2002-67882 gazette, disclosed is an anti-theft apparatus in which an inclination sensor (acceleration sensor) for use in detecting reversal which is incorporated in a reversal detection ECU (electronic control unit for detecting reversal of a vehicle to stop fuel injection and ignition) which was mounted on an auto-bicycle is also used for anti-theft. Concretely speaking, it is an anti-theft apparatus in which, by detecting a vibration component of a vehicle by use of the inclination sensor, the inclination sensor is also used as a vibration sensor for use in anti-theft.

[0004]

[Patent Document 1]

JP-A-2002-67882 gazette (pages 2-3, Fig.1)

[0005]

[Problem that the Invention is to Solve]

However, in case that various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are intended to be used also for anti-theft as an inclination sensor from the same view point as above, there was such a problem that it is not necessarily possible to surely detect inclination

of a vehicle from a problem of detection sensitivity.

[0006]

Explaining this concretely, for example, in an air bag ECU (electronic control unit for detecting a mechanical shock from a predetermined direction to have an air bag ignited) which is mounted on a vehicle, an acceleration sensor for detecting the shock is incorporated, but this detection sensitivity is generally set up to approximately ±50G~±300G from a view point of shock detection. In other words, to cite an example, detection sensitivity of a Y direction acceleration sensor (see, Fig.2(a)) which was disposed in a front collision air bag ECU is approximately ±100G.

[0007]

On one hand, in case that a vehicle was inclined due to jack-up and so on, as shown in Fig.2(b), change of acceleration due to gravity which does not normally appear as an output and is applied in a vertical direction appears in an acceleration sensor. And, by utilizing this output change of the acceleration sensor, a relation of "inclination angle - lift amount - acceleration sensor output" as shown in Fig.2(c) is logically derived. In addition, the relation shown in Fig.2(c) is one on the assumption that a vehicle with vehicle width of 165cm was inclined due to jack-up and so on.

[0008]

Here, focusing on a relation which was shown in Fig.2(a),

in case that such a state that a vehicle was lifted in a Y direction by approximately 20cm was assumed to be a critical point for anti-theft, in this state, an output of an acceleration sensor becomes approximately 125mV, and therefore, in order to surely detect this inclined state from the output of the acceleration sensor, detection sensitivity of approximately ±2G is required. Therefore, in the acceleration sensor which was cited above as an example, there is necessarily a limit to detect the critical point for anti-theft.

[0009]

In this manner, even if various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are also used for anti-theft as an inclination sensor, detection sensitivity is too much low as it is, and therefore, it is not necessarily possible to surely detect inclination of a vehicle due to jack-up and so on, and it was difficult to surely prevent theft of a vehicle and a tire.

[0010]

In addition, in the same manner as this, in case that the acceleration sensor is intended to be used for anti-theft as a vibration sensor (i.e., vibration of a vehicle due to a turbulent action which may lead to theft is intended to be detected), vibration generated due to such action is small as compared with vibration at the time of vehicle collision (i.e., detection sensitivity without any modification is too much low), and

therefore, it is not necessarily possible to surely detect vibration of a vehicle, and it was difficult to surely prevent theft of a vehicle and a tire.

[0011]

In this connection, this invention is one which was made for solving the above-described problem according to a related technology, and aims to provide an anti-theft apparatus, an anti-theft method and an anti-theft program which can surely detect a theft state of a vehicle, such as inclination and vibration of a vehicle due to a theft action, even in case that various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are used also for anti-theft.

[0012]

[Means for Solving the Problem]

In order to solve the above-described problem and to accomplish the object, an anti-theft apparatus which relates to an invention of claim 1 is one mounted on a vehicle for detecting acceleration in a predetermined direction and characterized by being equipped with an acceleration detection unit whose detection result in a first detection sensitivity is used for a predetermined vehicle control, a sensitivity switching unit for switching the detection sensitivity of the acceleration detection unit to a second detection sensitivity which is different from the first detection sensitivity when it received

an anti-theft instruction for instructing prevention of theft, and a theft judgment unit for judging whether or not the vehicle is in a theft state on the basis of the detection result of the acceleration detection unit which was switched to the second detection sensitivity by the sensitivity switching unit.

[0013]

Therefore, according to this invention, it is one which is mounted on a vehicle and which detects acceleration in a predetermined direction, and since it was designed that detection sensitivity of the acceleration detection unit whose detection result in the first detection sensitivity (e.g., it is detection sensitivity at which a mechanical shock for controlling an air bag can be detected, and approximately ±100G) is used for predetermined vehicle control is switched to the second detection sensitivity (concretely speaking, it is detection sensitivity which is available for theft judgment of a vehicle. For example, it is detection sensitivity at which inclination of a vehicle due to jack-up and so on can be detected, and approximately ±2G. Or detection sensitivity at which vibration of a vehicle due to a turbulent action which may lead to theft can be detected, and so on), and then, judged is whether or not a vehicle is in the theft state on the basis of the detection result of the acceleration detection unit which was switched to the second detection sensitivity, even in case that various acceleration sensors, which are mounted on a vehicle for an application other

than anti-theft, are also used for anti-theft, it becomes possible to surely detect the theft state of a vehicle.

[0014]

Also, an anti-theft apparatus which relates to an invention of claim 2 is characterized in that, in the invention as set forth in claim 1, the sensitivity switching unit switches respective detection sensitivities of a plurality of acceleration detection units which are mounted on the vehicle when it receives the anti-theft instruction, and the theft judgment unit judges whether or not the vehicle is in the theft state on the basis of respective detection results of the plurality of acceleration detection units.

[0015]

Therefore, according to the invention, since it was designed that respective detection sensitivities of the plurality of acceleration detection units which were mounted on a vehicle are switched in response to reception of the anti-theft instruction, and judged is whether or not a vehicle is in the theft state on the basis of respective detection results of the plurality of acceleration detection units, it is possible to judge the theft state (concretely speaking, inclination or vibration) in multiple aspects by a combination of detection results of the plurality of acceleration detection units and to prevent misjudgment, and it becomes possible to detect the theft state of a vehicle with a high degree of accuracy.

[0016]

also, an anti-theft apparatus which relates to an invention of claim 3 is characterized in that, in the invention as set forth in claim 2, the theft judgment unit judges that the vehicle is in the theft state, in case that acceleration which was detected by any one of acceleration detection units out of the plurality of acceleration detection units exceeds a predetermined threshold value.

[0017]

Therefore, according to this invention, since it was designed that it is judged that a vehicle is in a theft state in case that acceleration which was detected by any one of acceleration detection units out of the plurality of acceleration detection units exceeds a predetermined threshold value, it is possible to simply judges the theft state (concretely speaking, inclination or vibration) of a vehicle by the detection result of any one acceleration detection unit, and it becomes possible to detect the theft state of a vehicle as quickly as possible.

[0018]

Also, an anti-theft apparatus which relates to an invention of claim 4 is characterized in that, in the invention as set forth in claim 2, the theft judgment unit judges that the vehicle is in the theft state, in case that respective accelerations which were detected by a plurality of acceleration detection units for detecting acceleration in the same direction out of

the plurality of acceleration detection units exceed a predetermined threshold value.

[0019]

Therefore, according to this invention, since it was designed to judge that a vehicle in a theft state, in case that respective accelerations which were detected by a plurality of acceleration detection units for detecting acceleration in the same direction out of the plurality of acceleration detection units exceed a predetermined threshold value, it is possible to carefully judge a theft state (concretely speaking, inclination or vibration) of a vehicle by detection results of a plurality of acceleration detection units, and it becomes possible to detect the theft state of a vehicle with a high degree of accuracy.

[0020]

Also, an anti-theft apparatus which relates to an invention of claim 5 is characterized in that, in the invention as set forth any one of claims 1 to 4, the theft judgment unit judges whether or not the vehicle is in the theft state on the basis of inclination of the vehicle.

[0021]

Therefore, according to this invention, since it was designed to judge whether or not a vehicle is in a theft state on the basis of inclination of the vehicle, it becomes possible to surely detect inclination of a vehicle due to jack-up and

so on for theft.

[0022]

Also, an anti-theft apparatus which relates to an invention of claim 6 is characterized in that, in the invention as set forth in any one of claims 1 to 4, the theft judgment unit judges whether or not the vehicle is in the theft state on the basis of vibration of the vehicle.

[0023]

Therefore, according to this invention, since it was designed to judge whether or not a vehicle is in a theft state on the basis of vibration of the vehicle, it becomes possible to surely detect vibration of the vehicle due to a turbulent action which may lead to theft.

[0024]

Also, an anti-theft apparatus which relates an invention of claim 7 is characterized in that, in the invention as set forth in claim 6, the theft judgment unit judges whether or not the vehicle is in the theft state on the basis of a detection result of an acceleration detection unit which was disposed at an outer edge part of the vehicle.

[0025]

Therefore, according to this invention, since it was designed to judge whether or not a vehicle is in a theft state on the basis of the detection result of the acceleration detection unit which was disposed at the outer edge part of the vehicle,

in case that a theft state which is assumed to be vibration is intended to be detected, vibration which is applied to a vehicle is detected easier at the outer edge part, so that it becomes possible to improve detection accuracy.

[0026]

Also, an anti-theft apparatus which relates to an invention of claim 8 is characterized in that the sensitivity switching unit switches each detection sensitivity in such a manner that the second detection sensitivity of the acceleration detection unit which was disposed at a central part of the vehicle becomes higher than the second detection sensitivity of the acceleration detection unit which was disposed at the outer edge part of the vehicle.

[0027]

Therefore, according to this invention, since it was designed to switch each detection sensitivity in such a manner that the second detection sensitivity of the acceleration detection unit which was disposed at a central part of the vehicle becomes higher than the second detection sensitivity of the acceleration detection unit which was disposed at the outer edge part of the vehicle, it becomes possible to secure detection accuracy at the central part, taking into consideration that vibration which is applied to a vehicle is detected easier at the outer edge part.

[0028]

Also, an anti-theft apparatus which relates to an invention of claim 9 is characterized in that, in the invention as set forth in any one of claims 1 to 8, the acceleration detection unit is an acceleration sensor which was disposed in a front collision air bag ECU, an acceleration sensor which was disposed in a side collision air bag ECU, an acceleration sensor which is used for electronic control suspension and/or an acceleration sensor which is used for a vehicle stability control system.

[0029]

Therefore, according to this invention, since it was designed to utilize an acceleration sensor which was disposed in a front collision air bag ECU, an acceleration sensor which was disposed in a side collision air bag ECU, an acceleration sensor which is used for electronic control suspension and/or an acceleration sensor which is used for a vehicle stability control system, it is possible to detect a theft state (concretely speaking, inclination or vibration) by an acceleration sensor which is basically fixed to a vehicle stoutly and to which a behavior to the vehicle is directly applied, and thus, it becomes also possible to not only reduce a cost but also to improve detection accuracy, as compared with such a case that an anti-theft dedicated ECU is provided at later time.

[0030]

Also, an anti-theft apparatus which relates to an invention of claim 10 further comprises, in the invention as set forth

in any one of claims 1 to 9, a noise elimination unit for eliminating noise from the detection result of said acceleration detection unit, and is characterized in that the theft judgment unit judges whether or not the vehicle is in the theft state on the basis of the detection result from which noise was eliminated by the noise elimination unit.

[0031]

Therefore, according to the invention, since it was designed to eliminate noise from the detection result of the acceleration detection unit, and to judge whether or not a vehicle in a theft state on the basis of the detection result from which noise was eliminated, it is possible to remove a high-frequency noise component (high-frequency noise component according to vibration, which is different from inclination due to jack-up, and electromagnetic wave noise, and so on) which acts as a drag on the occasion of judging a theft state (concretely speaking, inclination or vibration) of a vehicle, and it becomes possible to judge the theft state of the vehicle with a high degree of accuracy.

[0032]

Also, an anti-theft apparatus which relates to an invention of claim 11 is characterized in that, in the invention as set forth in claim 10, the noise elimination unit eliminates the noise by switching a cutoff frequency of a filter which is additionally disposed in the acceleration detection unit to a

frequency which corresponded to theft judgment of the vehicle.

[0033]

Therefore, according to this invention, since it was designed to eliminate noise, by switching a cutoff frequency of a filter which is additionally disposed in the acceleration detection unit to a frequency which corresponded to theft judgment of the vehicle, it becomes possible to simply eliminate a high-frequency noise component, by switching of so-called high-pass and low-pass filer circuits.

[0034]

Also, an anti-theft apparatus which relates to an invention of claim 12 is characterized in that, in the invention as set forth in claim 10, the noise elimination unit eliminates said noise, by periodically integrating the detection result of the acceleration detection unit.

[0035]

Therefore, according to this invention, since it was designed to eliminate noise by periodically integrating the detection result of the acceleration detection unit, it becomes possible to simply eliminate a high-frequency noise component without using a filter circuit.

[0036]

Also, an anti-theft apparatus which relates to an invention of claim 13 is characterized in that, in the invention as set forth in claim 10, the noise elimination unit eliminates the

noise by switching a cutoff frequency of a filter which is additionally disposed in the acceleration detection unit to a frequency which corresponded to theft judgment of the vehicle, and by periodically integrating the detection result of the acceleration detection unit.

[0037]

Therefore, according to this invention, since it was designed to eliminate noise, by switching a cutoff frequency of a filter which is additionally disposed in the acceleration detection unit to a frequency which corresponded to theft judgment of the vehicle, and by periodically integrating the detection result of the acceleration detection unit, it becomes possible to simply and surely eliminate a high-frequency noise component, by simultaneous use of a filter circuit and periodical integration.

[0038]

Also, an anti-theft apparatus which relates to an invention of claim 14 is characterized in that, in the invention as set forth in any one of claims 1 to 13, the acceleration detection unit is contained in a predetermined unit together with various devices, and power is supplied thereto from a battery which was mounted on the vehicle or a dry battery which was contained in the predetermined unit, in the same manner as in the various devices, and further comprises a power supply control unit for controlling the power source only to the acceleration detection

unit in the predetermined unit, and the theft judgment unit judges whether or not the vehicle is in the theft state on the basis of the detection result of the acceleration detection unit which was controlled so as to supply the power source by the power supply control unit.

[0039]

Therefore, according to this invention, since it was designed to control so as to supply power only to an acceleration detection unit in a predetermined unit, in response to an anti-theft instruction, in case of utilizing an acceleration detection unit which is contained in a predetermined unit together with various devices, and to which power is supplied, in the same manner as various devices, from a battery which was mounted on a vehicle or a dry battery which was contained in the predetermined unit, and to judge whether or not a vehicle is in a theft state on the basis of the detection result of the acceleration detection unit which was controlled so as to supply the power source, it becomes possible to surely detect the theft state (concretely speaking, inclination or vibration) of a vehicle, in addition to effectively using power of the battery or the dry battery.

[0040]

Also, an anti-theft apparatus which relates to an invention of claim 15 is characterized in that, in the invention as set forth in claim 14, the power supply control unit controls so

as to intermittently supply the power source from the battery or dry battery to the acceleration detection unit.

[0041]

Therefore, according to this invention, since it was designed to control so as to intermittently supply the power source to the acceleration detection unit from the battery or dry battery, it is possible to more reduce consumption of the battery or dry battery, and it becomes possible to more effectively use power of the battery or dry battery.

[0042]

Also, an anti-theft apparatus which relates to an invention of claim 16 is characterized in that, in the invention as set forth in claim 14 or 15, the power supply control unit controls so as to stop supply of the power source to the acceleration detection unit, in case that a voltage of the battery or dry battery became a predetermined voltage and below.

[0043]

Therefore, according to this invention, since it was designed to control so as to stop supply of the power source to the acceleration detection unit, in case that a voltage of the battery or dry battery became a predetermined voltage and below, it becomes possible to urgently avoid consumption of the battery or dry battery, so as to secure power to a portion which is indispensable for a vehicle.

[0044]

Also, an anti-theft apparatus which relates to an invention of claim 17 further comprises, in the invention as set forth in any one of claims 1 to 16, a monitoring unit for monitoring a state of the vehicle and for sending out the anti-theft instruction, and is characterized in that the sensitivity switching unit switches detection sensitivity of the acceleration detection unit to detection sensitivity which is available for theft judgment of the vehicle, when it receives the anti-theft instruction which was sent out by the monitoring unit.

[0045]

Therefore, according to this invention, since it was designed to monitor a state of a vehicle and to send out an anti-theft instruction, and to switch detection sensitivity of the acceleration detection unit to detection sensitivity which is available for theft judgment of the vehicle, in response to the anti-theft instruction which was sent out, it becomes possible to properly send out the anti-theft instruction in accordance with such a state that the vehicle is parked and so on, and to switch the detection sensitivity always at appropriate timing.

[0046]

Also, an anti-theft apparatus which relates to an invention of claim 18 is characterized in that, in the invention as set forth in claim 17, the monitoring unit monitors an ON-OFF state

of an ignition key, and sends out the anti-theft instruction, in case that the ignition key was turned to the OFF state.

[0047]

Therefore, according to this invention, since it was designed to monitor the ON-OFF state of the ignition key and to send out the anti-theft instruction in case that the ignition key was turned to the OFF state, it is possible to automatically send out the anti-theft instruction, assuming that the OFF state of the ignition key is deemed to be a parked state of the vehicle, and it becomes possible to switch the detection sensitivity always at appropriate timing, without necessity of a special operation for anti-theft by a driver.

[0048]

Also, an anti-theft method which relates to an invention of claim 19 is characterized by including an acceleration detection step of detecting acceleration in a predetermined direction, a result of said detection in a first detection sensitivity being used for a predetermined vehicle control, a sensitivity switching unit of switching the detection sensitivity of the acceleration detection step to a second detection sensitivity which is different from the first detection sensitivity when an anti-theft instruction for instructing prevention of theft was received, and a theft judgment step of judging whether or not the vehicle is in a theft state on the basis of the detection result of the acceleration detection step

which was switched to the second detection sensitivity by the sensitivity switching step.

[0049]

Therefore, according to this invention, since it was designed that acceleration of a vehicle in a predetermined direction is detected, and detection sensitivity of the acceleration detection step whose detection result in the first detection sensitivity (e.g., it is detection sensitivity at which a mechanical shock for controlling an air bag can be detected, and approximately ±100G) is used for predetermined vehicle control is switched to the second detection sensitivity (concretely speaking, it is detection sensitivity which is available for theft judgment of a vehicle. For example, it is detection sensitivity at which inclination of a vehicle due to jack-up and so on can be detected, and approximately ±2G. Or detection sensitivity at which vibration of a vehicle due to a turbulent action which may lead to theft can be detected, and so on), and then, in case that acceleration which was switched to the second detection sensitivity and detected in the acceleration detection step exceeds the predetermined threshold value, it was judged is that the vehicle is in the theft state, even in case that various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are also used for anti-theft, it becomes possible to surely detect the theft state of a vehicle.

[0050]

Also, an anti-theft program which relates to an invention of claim 20 is characterized by having a computer executed an acceleration detection step of detecting acceleration in a predetermined direction, a result of the detection in a first detection sensitivity being used for a predetermined vehicle control, a sensitivity switching unit of switching the detection sensitivity of the acceleration detection step to a second detection sensitivity which is different from the first detection sensitivity when an anti-theft instruction for instructing prevention of theft was received, and a theft judgment step of judging whether or not the vehicle is in a theft state on the basis of the detection result of the acceleration detection step which was switched to the second detection sensitivity by the sensitivity switching step.

[0051]

Therefore, according to this invention, since it was designed that acceleration of a vehicle in a predetermined direction is detected, and detection sensitivity of the acceleration detection step whose detection result in the first detection sensitivity (e.g., it is detection sensitivity at which a mechanical shock for controlling an air bag can be detected, and approximately ±100G) is used for predetermined vehicle control is switched to the second detection sensitivity (concretely speaking, it is detection sensitivity which is

available for theft judgment of a vehicle. For example, it is detection sensitivity at which inclination of a vehicle due to jack-up and so on can be detected, and approximately ±2G. Or detection sensitivity at which vibration of a vehicle due to a turbulent action which may lead to theft can be detected, and so on), and then, in case that acceleration which was switched to the second detection sensitivity and detected in the acceleration detection step exceeds the predetermined threshold value, it was judged is that the vehicle is in the theft state, even in case that various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are also used for anti-theft, it becomes possible to surely detect the theft state of a vehicle.

[0052]

[Mode for Carrying Out the Invention]

Hereinafter, with reference to the accompanying drawings, as a first embodiment, a preferred embodiment of an anti-theft apparatus, an anti-theft method and an anti-theft program which relate to this invention will be described in detail. In addition, in the following, after an overview and a feature of an anti-theft apparatus which relates to this invention is described, a structure and process procedures of this anti-theft apparatus will be described, and finally, as other embodiments, various modifications will be described.

[0053]

(Overview and Features of Anti-theft Apparatus)

At the beginning, an overview and features of the anti-theft apparatus which relates to this invention will be described. Fig.1 is a view showing a functional conceptual schematic structure of the anti-theft apparatus which relates to this invention. As shown in the same figure, this anti-theft apparatus, schematically, is one which uses an acceleration sensor 11 which is incorporated in an air bag ECU 10 (electronic control unit for detecting a mechanical shock from a predetermined direction to ignite an air bag) which was mounted on a vehicle, as an inclination sensor, and which prevent theft of a vehicle and a tire due to jack-up and so on.

[0054]

In other words, as shown in Fig.2(a), various acceleration sensors are mounted on a vehicle, and, in the anti-theft apparatus which relates to this invention, in case that a vehicle is parked, a detection result of the acceleration sensor 11 which was disposed in the air bag ECU 10 for use in front collision is outputted to an anti-theft ECU 20. And, in an inclination judgment part of this anti-theft ECU 20, inclination of a vehicle is judged on the basis of the detection result of the acceleration sensor 11, and in case that the vehicle is being inclined to such extent that theft due to jack-up is assumed, an anti-theft alarm is outputted through an alarm part 22.

[0055]

In this manner, the anti-theft apparatus which relates to this embodiment is one which intends to prevent theft due to jack-up and so on by utilizing the acceleration sensor 11 which was disposed in the air bag ECU 10, but a main feature of this anti-theft apparatus is on such a point that, even in case that an acceleration sensor which is mounted on a vehicle for an application other than anti-theft is also used for anti-theft, like the acceleration sensor 11 of the air bag ECU 10, it is possible to surely detect inclination of a vehicle due to jack-up and so on.

[0056]

Describing this concretely, in case of a Y direction acceleration sensor (see, Fig.2(a)) which was disposed in the front collision air bag ECU 10, its detection sensitivity is set up to approximately ±100G from the view point of shock detection. On the other side, when assumed is such a state that a vehicle with vehicle width of 165cm is lifted in a Y direction by approximately 20cm due to jack-up and so on, since an output of the acceleration sensor 11 in this state becomes approximately 125mv (see, Figs.2(b) and (c)), in order to surely detect this inclination state, detection sensitivity of approximately ±2G is required.

[0057]

In shirt, detection sensitivity which is required on the occasion of anti-theft (detection of inclination of a vehicle

due to jack-up and so on) (approximately ±2G) is remarkably high as compared with detection sensitivity which is necessary for detecting a shock (approximately ±10G). Therefore, in case that such a state that a vehicle was lifted in a Y direction by approximately 20cm was assumed to be a critical point for anti-theft, even if the acceleration sensor 11 is intended to be used for anti-theft as an inclination sensor, since detection sensitivity is too much low as it is, it is not necessarily possible to surely detect inclination of a vehicle due to jack-up and so on.

[0058]

In this connection, in this embodiment, a GAIN switching part 16 of the air bag ECU 10 switches detection sensitivity of the acceleration sensor 11 to detection sensitivity which is available for theft judgment (inclination judgment) of a vehicle (approximately ±2G), and an inclination judgment part 21 of the anti-theft ECU 20 judges whether or not a vehicle is in a theft state (whether or not a vehicle is being inclined due to a theft action) on the basis of a detection result of the acceleration sensor 11 which was switched to the such detection sensitivity. That is, by this, it is designed to be able to surely detect inclination of a vehicle due to jack-up and so on. In addition, in Fig.1, the acceleration sensor 11, the GAIN switching part 16 and the inclination judgment part 21 correspond to "acceleration detection unit", "sensitivity

switching unit" and "theft judgment unit" as described in the claims, respectively.

[0059]

Also, the anti-theft apparatus which relates to this embodiment is one which has also additionally features as recited in the following with regard to the above-described main feature. In other words, in this embodiment, in alignment with the above-described switching of detection sensitivity, a noise elimination part 17 of the air bag ECU 10 switches a cutoff frequency of a filter which is additionally disposed in the acceleration sensor 11 from 200Hz to approximately 50Hz. That is, by this, it is designed to be able to eliminate a high-frequency noise component (high-frequency noise component according to vibration, which is different from inclination due to jack-up, and electromagnetic wave noise, and so on) which acts as a drag on the occasion of judging inclination of a vehicle from the detection result of the acceleration sensor 11, and to be able to judge inclination of the vehicle with a high degree of accuracy. In addition, in Fig.1, the noise elimination part 17 corresponds to "noise elimination unit" as described in the claims.

[0060]

Also, in this embodiment, in alignment with the above-described switching of detection sensitivity, a power supply control part 18 of the air bag ECU 10 switches power source supply so as to supply power from a battery 30 only to the

acceleration sensor 11 in the air bag ECU 10 (i.e., stops power source supply to another devices such as a CPU which is originally incorporated in the air bag ECU 10 and which performs a function while driving, and so on). That is, by this, it is designed to be able to surely detect inclination of a vehicle, in addition to effectively using power of the battery 11. In addition, in Fig.1, the power supply control part 18 corresponds to "power supply unit" as described in the claims.

[0061]

Further, in this embodiment, an IG key monitor 19 of the air bag ECU 10 monitors an ON-OFF state of an IG key SW (ignition key switch) 40, and in case that it was turned to the OFF state, an anti-theft instruction is sent out to the noise elimination part 17 and the power supply control part 18, to have switching of detection sensitivity, switching of a filter and switching of power supply executed, respectively. That is, by this, it is designed to automatically send out the anti-theft instruction, assuming that the OFF state of the IG key SW 40 is deemed to be a parked state of a vehicle, and to always switch detection sensitivity always at appropriate timing, without necessity of a special operation for anti-theft by a driver. In addition, in Fig.1, the IG key monitor 19 corresponds to "monitoring unit" as described in the claims.

[0062]

(Structure of Anti-theft Apparatus)

Next, a structure of the anti-theft apparatus which relates to this embodiment will be described. Fig.2 is a block diagram showing a structure of the anti-theft apparatus which relates to this embodiment. As shown in the same figure, this anti-theft apparatus is configured by connecting the air bag ECU 10 and the anti-theft ECU 20, and, in the following, after (1) a structure of the air bag ECU 10 and (2) a structure of the anti-theft ECU 20 will be described, respectively, (3) a structure of a peripheral circuit of the acceleration sensor 11 will be described.

[0063]

(1) Air Bag ECU

The air bag ECU 10 is basically an electronic control unit for detecting shocks from a front direction and a lateral direction, when a vehicle is in operation (in case that the IG key SW 40 is in the ON state) as the front collision air bag ECU 10 (see, Fig.1(a)) to ignite an air bag. And, as its basic structure, as shown in Fig.3, it is equipped with X direction acceleration sensor 11a and Y direction acceleration sensor 11b (correspond to the acceleration sensor 11 shown in Fig.1), a CPU 12, and a backup power source 13, an ASIC 14, a 5V power source 18c, and a boosting power source 18d.

[0064]

That is, in this air bag ECU 10, in case that the IG key SW 40 is in the ON state, from the X direction acceleration sensor

11a and Y direction acceleration sensor 11b (hereinafter, these are referred to acceleration sensor 11 at pleasure) for detecting respective accelerations in the X direction and Y direction, detection results are inputted to the CPU 12. And, the CPU 12 judges whether or not there occurred a shock due to collision of a vehicle from that detection result, and in case that the suchlike shock was detected, by a squib 15 (processing part for having chemicals (inflator), which generates nitrogen system gas, burnt) through the ASIC 14, it is controlled to blow up the bag instantaneously.

[0065]

In addition, in fig.3, the 5V power source 18c is means for carrying out voltage conversion in order to obtain a voltage of ±5V from an input voltage (battery 30 or backup power source 13), and the backup power source 13 is means for boosting the input voltage through the boosting power source 18d, in case that a voltage of the battery 30 became a allowable value and below, and for supplying a power source to each acceleration sensor 11, the CPU 12 and the ASIC 14.

[0066]

On one hand, the air bag ECU 10 is, other than the suchlike basic structure, as a structure which relates to the above-described feature, as shown in Fig.3, equipped with a X direction GAIN switching part 16a and a Y direction GAIN switching part 16b (correspond to the GAIN switching part 16 shown in Fig.1),

a X direction filter switching part 17a and a Y direction filter switching part 17b (correspond to the noise elimination part 17 shown in Fig.1), a power supply control SW 18a and a power supply control SW 18b (correspond to the power supply control part 18 shown in Fig.1), and an IG key monitor 19. A structure which relates to these features will be described.

[0067]

The X direction GAIN switching part 16a and Y direction GAIN switching part 16b (hereinafter, these are referred to as GAIN switching part 16 at pleasure) is a processing part which receives an anti-theft instruction from the IG key monitor 19, and which switches detection sensitivity of each acceleration sensor 11 to detection sensitivity which is available for inclination judgment. Concretely speaking, with regard to the X direction acceleration sensor 11a, it switches detection sensitivity which was set up to approximately ±50G from the viewpoint for detecting a shock to approximately ±2G, and with regard to the Y direction acceleration sensor 11b, it switches detection sensitivity which was set up to approximately ±100G in the same manner to detection sensitivity of approximately ±20G. As a result, after the IG key SW 40 was turned to the OFF state, an acceleration sensor output of the acceleration sensor 11 is outputted to the anti-theft ECU 20 with resolution of approximately ±2G. In addition, this switching of the detection sensitivity will be described later as "(3) Structure

of Peripheral Circuit of Acceleration Sensor".

[0068]

The X direction filter switching part 17a and Y direction filter switching part 17b (hereinafter, these are referred to as noise elimination part 17 at pleasure) is a processing part which receives an anti-theft instruction from the IG key monitor 19, and which switches a cutoff frequency of a filter in order to eliminate high-frequency noise from detection result of each acceleration sensor 11. Concretely speaking, it switches the filter from high-pass of approximately 200Hz (low-cut) to low-pass of approximately 50Hz (high-cut). In addition, this switching of the filter will be also described later as "(3) Structure of Peripheral Circuit of Acceleration Sensor".

[0069]

The power supply control SW 18a and the power supply control SW 18b (hereinafter, these are referred to as power supply control part 18 at pleasure) is a processing part which receives the anti-theft instruction from the IG key monitor 19, and which switches power supply so as to supply power from the battery 30 only to the acceleration sensor 11 in the air bag ECU 10. Concretely speaking, as shown in Fig.3, in case that the IG key SW 40 was turned to the OFF state, receiving the anti-theft instruction from the IG key monitor 19, the power supply control SW 18a is turned to the "ON" state and the power supply control SW 18b is turned to the "OFF" state, and as a result of that,

power supply to the CPU 12 and so on is stopped, and power is supplied only to the acceleration sensor 11.

[0070]

The IG key monitor 19 is a processing part which monitors the ON/OFF states of the IG key SW 40, and which, in case that the IG key SW 40 was turned to the OFF state, sends out the anti-theft instruction to the GAIN switching part 16, the noise elimination part 17 and the power supply control part 18. In addition, in case that the IG key SW 40 was turned to the ON state, it sends out an anti-theft release instruction to each part, and switches each to such a state that a vehicle is in operation.

[0071]

(2) Anti-theft ECU

Subsequently, a structure of the anti-theft ECU 20 will be described, but this anti-theft ECU 20 is, as shown in Fig.3, equipped with a 5V power source 23, a receiving circuit 25, a transmission circuit 26, and an output TR 27, and a emergency notification transmission antenna 22a, a siren 22b, a hazard lamp 22c, a head lamp 22d, and a security receiving antenna 24 are connected thereto.

[0072]

Here, the CPU 21 (corresponds to the inclination judgment part 21 shown in Fig.1) is a processing part which judges whether or not a vehicle is in a theft state (concretely speaking, whether

or not it is inclined), on the basis of a detection result of the acceleration sensor 11 in the air bag ECU 10. Concretely speaking, it judges whether or not a detection result in the X direction acceleration sensor 11a or the Y direction acceleration sensor 11b exceeds a threshold value (e.g., 0.1G). In addition, this threshold value is a threshold value in case of surely detecting such a state that a vehicle with vehicle width of 165cm was lifted by 20cm and more, and since resolution of a microcomputer A/D is 10bit (1024LSB) and 1LSB = 4mG is realized, 0.1G (25LSB) is made to be a detection threshold value.

[0073]

And, the CPU (inclination judgment part) 21 carries out the following alarm action in case that the detection result of the acceleration sensor 11 exceeds the threshold value. That is, alarm siren is sounded from the siren 22b through the output TR 27, and the hazard lamp 22c and/or the head lamp 22d are made to be flashed, and further, an emergency situation is notified to an owner from the emergency notification antenna 22a through the transmission circuit 26.

[0074]

In addition, the CPU 21 receives ON/OFF of security from the security receiving antenna 24 through the receiving circuit 25, and changes a function of the anti-theft ECU 20 to the OFF state, in case that the anti-theft ECU 20 is not desired to be operated for various circumstances such as repair of a vehicle,

tow of a vehicle, and so on. Also, the anti-theft ECU 20 receives supply of a power source from the battery 30 through the 5V power source 23 for carrying out voltage conversion for obtaining a voltage of ±5V from the input voltage, and is operated.

[0075]

(3) Structure of Peripheral Circuit of Acceleration Sensor

Subsequently, a structure of a peripheral circuit of the acceleration sensor 11 will be clarified, and then, detection sensitivity switching and filter switching will be described. Fig.4 is a view showing a structure of a peripheral circuit of the acceleration sensor, and Fig.5 is a view illustrating the detection sensitivity switching and filter switching.

[0076]

As shown in Fig.4, in an acceleration sensor IC in which an acceleration sensor chip and an AMP (amplifier) were incorporated, an output terminal of the acceleration sensor chip is connected to an input terminal of a microcomputer (CPU 12 or CPU 21 shown in Fig.3) through a capacitor C1, a resistor R2 (100K) and a resistor R1 (100k). Also, in the AMP (amplifier) of the acceleration sensor IC, a reference power source 2.5V is connected to a plus side input terminal, and also, a minus side input terminal (Vi) is connected to connection terminals of the resistors R1 and R2, and an output terminal (Vo) is connected to an input terminal of a microcomputer. Further, as shown in the same figure, a filter switching SW 2 is parallel-connected

to the capacitor C1, and a resistor 2' and a GAIN switching SW 1 are parallel-connected to the resistor R2, and a capacitor C2 and a filter switching SW 3 are parallel-connected to the resistor R1.

[0077]

In the suchlike circuit structure, in case that the IG key SW 40 is in the ON state, as shown in Fig.5(a), by control of the IG key monitor 19, the GAIN switching SW 1, the filter switching SW 2 and the filter switching SW 3 are all turned to the OFF state. And, in this case, since a circuit shown in fig.4 becomes a structure shown in Fig.5(b) (i.e., Vo=-(Vi-2.5)R1/R2 is realized.), GAIN becomes approximately ±50G, and a cutoff frequency of a filter becomes 200Hz (high-pass).

[0078]

In case that the IG key SW 40 was turned to the OFF state from the suchlike state, receiving the anti-theft instruction from the IG key monitor 19, the GAIN switching SW 1, the filter switching SW 2 and the filter switching SW 3 are all turned to the ON state. And, in this case, since a circuit shown in fig.4 becomes a structure shown in Fig.5(c) (i.e., Vo=-(Vi-2.5)R1/R3, R3 = R2xR2'(R2+R2') are realized.), GAIN is switched to approximately ±2G, and a cutoff frequency of the filter becomes 50Hz (low-pass).

[0079]

(Process Procedure of Anti-theft Apparatus)

Next, process procedures of the anti-theft apparatus which relates to this embodiment will be described. Fig.6 is a flow chart showing process procedures of the anti-theft apparatus which relates to this embodiment. As shown in the same figure, the IG key monitor 19 of the air bag ECU 10 repeatedly monitors whether or not the IG key SW 40 was turned to the OFF state (step S601).

[0080]

And, in case that the IG key SW 40 was turned to the OFF state (affirmative in the step S601), the IG key monitor 19 sends out the anti-theft instruction to the GAIN switching part 16, the noise elimination part 17 and the power supply control part 18, and has switching of detection sensitivity (GAIN), switching of the filter and switching of power supply executed, respectively (step S602). That is, detection sensitivity of the acceleration sensor 11 is switched to approximately ±2G, and also, the filter is switched to low-pass (high-cut) of approximately 50Hz, and further, power supply is switched so as for the power source to be supplied only to the acceleration sensor 11.

[0081]

Subsequently, the inclination judgment part 21 successively judges whether or not a detection result of the acceleration sensor 11 exceeds a threshold value (e.g., 0.1G) (step S603), and further, the IG key monitor 19 successively

monitors whether or not the IG key SW 40 was turned to the ON state (step S605). As a result, in case that the detection result of the acceleration sensor 11 is exceeding the threshold value (affirmative in the step S603), the inclination judgment part 21 outputs alarm through the siren 22b, the hazard lamp 22c, the head lamp 22d and/or emergency notification antenna 22a (step S604).

[0082]

On one hand, in case that the IG key SW 40 was turned to the ON state (affirmative in the step S605), the IG key monitor 19 sends out an anti-theft release instruction to the GAIN switching part 16, the noise elimination part 17 and the power supply control part 18, and switches each to such a state that a vehicle is in operation (step S606). That is, detection sensitivity of the acceleration sensor 11 is switched to approximately ±100G, and also, the filter is switched to high-pass (low-cut) of approximately 200Hz, and further, power supply is switched so as for the power source to be supplied to the CPU 12 and so on other than the acceleration sensor 11.

[0083]

As described above, according to the anti-theft apparatus which relates to this embodiment, even in case that the acceleration sensor 11 of the air bag ECU 10 which is mounted on a vehicle for an application other than anti-theft is also used for anti-theft, it becomes possible to surely detect

inclination of a vehicle due to jack-up and so on. In addition, since it is possible to detect the inclination by an acceleration sensor which is basically fixed to a vehicle stoutly and to which a behavior to the vehicle is directly applied, it becomes possible to not only reduce a cost but also to improve detection accuracy, as compared with such a case that an anti-theft dedicated ECU (electronic control unit) is provided at later time.

[0084]

Also, according to the anti-theft apparatus which relates to this embodiment, since it is possible to eliminate a high-frequency noise component which acts as a drag on the occasion of judging inclination of a vehicle, it becomes possible to judge the inclination of the vehicle with a high degree of accuracy. Also, it becomes possible to surely detect inclination of a vehicle, in addition to effectively using power of the battery 11. Further, since it is possible to automatically send out the anti-theft instruction, assuming the OFF state of the IG key SW 40 to be such a state that a vehicle is in operation, it becomes possible to switch the detection sensitivity and so on always at appropriate timing, without necessity of a special operation for anti-theft by a driver.

[0085]

(Other Embodiment)

In the meantime, up to this, the embodiments of this invention were described, but this invention, other than the

above-described embodiments, may also be carried out by various different embodiments within the scope of a technical concept which was described in claims. In this connection, in the following, different embodiments will be described by separating into (1) structure, (2) acceleration sensor, (3) noise elimination, (4) power supply, (5) anti-theft instruction, and (6) vibration of a vehicle, respectively.

[0086]

(1) Structure

In this embodiment, described was such a case that structures which relates to features of this invention, like the GAIN switching part 16, the noise elimination part 17, the power supply control part 18 and the IG key monitor 19 are mounted on the air gab ECU 10, but this invention is not limited to this, and is also applicable in the same manner to, for example, such a case that all or a part of these structures are mounted on a part other than the air bag ECU 10, such as these structures being mounted on the anti-theft ECU 20, and so on. In the same manner as this, each structural element of the anti-theft apparatus shown in Figs.1 and 3 is functional conceptual one, and it is not necessarily required that it is configured physically as shown in the figure, and it is possible to configure it by functionally or physically dispersing/integrating all or a part of them with an arbitrary unit, according to a processing load, a manufacturing state, a use state and so on.

[0087]

Further, a circuit structure and an ON/OFF theory of the anti-theft apparatus shown in Figs.3 and 4 are not limited to ones shown in the figures, but may be configured by another circuit and theory which perform similar functions. Also, in the same manner as this, with regard to each processing function which is carried out in the anti-theft apparatus which relates to this embodiment, all or an arbitrary part of them may be realized by a CPU and a program which is analytically executed by the CPU, or may be realized as hardware according to wired logic.

[0088]

Also, it is possible to automatically carry out all or a part of processing (e.g., switching of detection sensitivity, switching of a filter, switching of a power source, and so on) which was described as one which is automatically carried out, out of each processing which is carried out in the anti-theft apparatus which relates to this embodiment. Further, it is possible to arbitrarily change process procedures, control procedures and concrete names which were shown in the above text and figures, and information including various data and parameters (e.g., threshold value of inclination judgment, GAIN value, cutoff frequency, resistor value, and so on) except for a specified case.

[0089]

(2)Acceleration Sensor

In this embodiment, described was such a case that both of the X direction acceleration sensor 11a and the Y direction acceleration sensor 11b which were incorporated in the front collision air bag ECU 10 are also used for anti-theft, but this invention is not limited to this, and is also applicable in the same manner to such a case that only one direction inclination judgment is carried out by only one of these (e.g., Y direction acceleration sensor 11b).

[0090]

Also, in this embodiment, described was such a case that the acceleration sensor which was incorporated in the front collision air bag ECU 10 is also used for anti-theft, but this invention is not limited to this, and is applicable in the same manner to any acceleration sensor which was mounted on a vehicle. That is, as shown in Fig.2(a), on a vehicle, an acceleration sensor which was disposed in a side collision air bag ECU (right side-side collision Y direction acceleration sensor, left side-side collision Y direction acceleration sensor), an acceleration sensor which was disposed in a front collision front satellite sensor (left side-front collision X direction acceleration sensor, right side-front collision X direction acceleration sensor), a Z direction acceleration sensor which is used in an electronic control suspension, and a Y direction acceleration sensor which is used in a vehicle stability control system are mounted, but these acceleration sensors may be also

used for anti-theft in the same manner. In addition, even in case that these acceleration sensors are also used for anti-theft, its detection sensitivity is switched to approximately ±2G, but a threshold value of inclination judgment may be differentiated with respect to each acceleration sensor according to its mounting position.

[0091]

Also, in this invention, a plurality of acceleration sensors as described above may be also used for anti-theft, and inclination of a vehicle may be judged on the basis of each detection result. That is, to cite an example, it is a combination such as the left side-front collision X direction acceleration sensor and/or the right side-front collision X direction acceleration sensor and, the right side-side collision Y direction acceleration sensor and/or the left side-side collision acceleration sensor. By this, it is possible to judge the inclination in multiple aspects by a combination of detection results of the plurality of acceleration sensors and to prevent misjudgment, and it becomes possible to detect inclination of a vehicle with a high degree of accuracy.

[0092]

Also, in case that the plurality of acceleration sensors are also used for inclination judgment as described above, it is possible to judge that a vehicle is inclined, when a detection result of any one acceleration sensor exceeds the threshold value.

That is, to cite an example, in case that the Y direction acceleration sensor 11b, the right side-side collision acceleration sensor and the left side-side collision Y direction acceleration sensor in the front collision air bag ECU 10 are also used for inclination judgment, if any one detection result exceeds the threshold value, an alarm action will be carried out. By this, it is possible to simply judge the inclination of a vehicle on the basis of a detection result of any one acceleration sensor, and it becomes possible to promptly detect inclination of a vehicle.

[0093]

Further, in case that a plurality of same direction acceleration sensor are also used for inclination judgment as described above, it may be possible to judge on such a condition that all of respective detection results exceed the threshold value. That is, speaking on the above-described example, in case that all detection results of the Y direction acceleration sensor 11b, the right side-side collision Y direction acceleration sensor, and the left side-side collision Y direction acceleration sensor exceeded the threshold value, an alarm action is carried out for the first time. By this, it is possible to carefully detect inclination of a vehicle on the basis of detection results of the plurality of acceleration sensors, and it becomes possible to detect inclination of a vehicle with a high degree of accuracy.

[0094]

(3)Noise Elimination

In this embodiment, described was such a case that noise is eliminated by a filter, but this invention is not limited to this, and is also applicable in the same manner to every noise elimination methods, such as, for example, periodical integration of a detection result of an acceleration sensor. That is, it is possible to simply eliminate a high-frequency noise component by periodical integration and so on, without using a filter circuit.

[0095]

Also, in this invention, it becomes possible to simply and surely eliminate a high-frequency noise component, not only by use of noise elimination by a filter but also by simultaneous use of noise elimination according to periodical integration as described above. In addition, also in case of adopting the noise elimination by periodical integration, in the same manner as switching of a cutoff frequency of a filter (switching of low-pass and high-pass), a band of noise which is an object to be eliminated is switched.

[0096]

(4)Power Supply

In this embodiment, described was such a case that power is supplied from the battery 30 of a vehicle, but this invention is not limited to this, and is also applicable in the same manner

to such a case that power is supplied from other part than the battery 30, such as power being supplied from a dry battery which was mounted on the air bag ECU 10 and the anti-theft ECU 20, and so on. In addition, even in case that power is supplied from the dry battery which was mounted on the air bag ECU 10 and the anti-theft ECU 20, it is controlled so as to supply power only to the acceleration sensor, in response to the anti-theft instruction.

[0097]

Also, in this invention, in case that power is supplied only to the acceleration sensor in the OFF state of the IG key SW 40, it may be controlled so as to intermittently supply power. That is, by this, it is possible to further reduce consumption of the battery and dry battery, and it becomes possible to surely detect inclination of a vehicle, in addition to effectively using power of the battery or the dry battery.

[0098]

Further, in this invention, in case that a voltage of the battery or the dry battery becomes a predetermined voltage and below, as well as intermittent supply of power, it may be controlled so as to stop supply of power to the acceleration sensor. That is, by this, it becomes possible to urgently avoid consumption of the battery or dry battery, and to secure power to a portion which is indispensable for a vehicle.

[0099]

(5)Anti-theft Instruction

In this embodiment, described was such a case that the IG key monitor 19 monitors the ON/OFF states of the IG key SW 40 to send out the anti-theft instruction to the GAIN switching part 16 and so on, but this invention is not limited to this, and is also applicable in the same manner to such a case that another state other than the IG key SW 40 (e.g., a drive state of an engine, a state of other switch and device, and so on) is monitored to send out the anti-theft instruction.

[0100]

Also, in this invention, it may be designed to dispose a dedicated SW like an anti-theft instruction switch in a vehicle, and to send out the anti-theft instruction after the suchlike dedicated SW was operated so as to be turned ON. Furthermore, it may also be designed to combine this with the IG key SW 40, and to send out the anti-theft instruction after the ON operation of the dedicated SW and the OFF state of the IG key SW 40 were waited.

[0101]

(6)Vibration of Vehicle

In this embodiment, described was such a case that the acceleration sensor is also used as an inclination sensor, and theft of a vehicle and a tire due to jack-up and so on is prevented, but this invention is not limited to this, and is also applicable in the same manner to such a case that the acceleration sensor

is also used as an inclination sensor, and theft is prevented by detecting vibration of a vehicle due to a turbulent action which may lead to theft.

[0102]

That is , in this case, in order to judge whether or not a vehicle is in a theft state (concretely speaking, whether or not a turbulent action which may lead to theft is carried out), judged is whether or not a vehicle is vibrated on the basis of acceleration which is the detection result of the acceleration sensor 11. And, also in this case, in the same manner as the above-described embodiment, since vibration which is generated by the suchlike action is smaller as compared with vibration at the time of vehicle collision (i.e., detection sensitivity is too much low as it is, so as to be able to surely detect vibration of a vehicle, detection sensitivity of the acceleration sensor 11 is switched to detection sensitivity which is available for vibration detection of a vehicle. In this regard, however, since inclination and vibration of a vehicle are of different actions which are targeted to be detected, used are ones whose concrete values are different from the above-described detection sensitivity and threshold value described above.

[0103]

Also, in case of vibration judgment of a vehicle, it is desirable to judge whether or not a vehicle is in a theft state on the basis of a detection result of an acceleration sensor

(e.g., a front sensor, a side collision sensor, and so on) which was disposed at an outer edge part of a vehicle. In other words, since vibration which is applied to a vehicle is detected easier at the outer edge part, by this, it becomes possible to improve detection accuracy.

[0104]

Further, in case of vibration judgment of a vehicle, it is desirable to switch each detection sensitivity in such a manner that detection sensitivity of the acceleration sensor which was disposed at a central part of a vehicle (e.g., front collision sensor, and so on) becomes higher than detection sensitivity of the acceleration sensor which was disposed at the outer edge part of the vehicle. In other words, by this, it becomes possible to secure detection accuracy at the central part, taking into consideration that vibration which is applied to a vehicle is detected easier at the outer edge part. In addition, from the same viewpoint as this, in case of vibration judgment of a vehicle, used are threshold values for vibration judgment which differ respectively according to a difference of a position of an acceleration sensor.

[0105]

In addition, also in case of vibration judgment of a vehicle, the features of this application, which were described in the above-described embodiment and other embodiments (1)-(5) such as switching a cutoff frequency of a filter and switching power

supply and so on in alignment with switching of detection sensitivity, is applicable in the same manner.

[0106]

Finally, the anti-theft method which was described in this embodiment can be realized by executing a program which was provided in advance on a computer (including an external computer) which was mounted on a vehicle. This program can be distributed through a network such as Internet and so on. Also, this program can be executed by being recorded on a computer-readable recording medium such as a hard disc, a flexible disc (FD), a CD-ROM, a MO, a DVD and so on, and by being read out from the recording medium by a computer.

[0107]

[Advantage of the Invention]

As described above, according to the invention of claim 1, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can surely detect a theft state of a vehicle, even in such a case that various acceleration sensors which are mounted on a vehicle from an application other than anti-theft is also used as anti-theft.

[0108]

Also, according to the invention of claim 2, achieved is such an advantage that it is possible to judge the theft state (concretely speaking, inclination or vibration) in multiple aspects by a combination of detection results of the plurality

of acceleration detection units and to prevent misjudgment, and it is possible to obtain an anti-theft apparatus which can detect the theft state of a vehicle with a high degree of accuracy.

[0109]

Also, according to the invention of claim 3, achieved is such an advantage that it is possible to simply judge a theft state (concretely speaking, inclination or vibration) of a vehicle by a detection result of any one of acceleration detection units, and it is possible to obtain an anti-theft apparatus which can detect the theft state of a vehicle with a high degree of accuracy.

[0110]

Also, according to the invention of claim 4, achieved is such an advantage that it is possible to carefully detect the theft state (concretely speaking, inclination or vibration) of a vehicle by detection results of a plurality of acceleration detection units, and it is possible to obtain an anti-theft apparatus which can detect the theft state of a vehicle with a high degree of accuracy.

[0111]

Also, according to the invention of claim 5, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can surely detect inclination of a vehicle due to jack-up and so on for theft.

[0112]

Also, according to the invention of claim 6, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can surely detect vibration of a vehicle due to a turbulent action which may lead to theft.

[0113]

Also, according to the invention of claim 7, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can improve detection accuracy, since vibration which is applied to a vehicle is detected easier at an outer edge part, in case of detecting a theft state assuming vibration.

[0114]

Also, according to the invention of claim 8, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can secure detection accuracy at the central part, taking into consideration that vibration which is applied to a vehicle is detected easier at the outer edge part.

[0115]

Also, according to the invention of claim 9, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can judge the theft state (concretely speaking, inclination or vibration) by an acceleration sensor which is basically fixed to a vehicle stoutly and to which a behavior to the vehicle is directly applied, and thus, can not only reduce a cost but also improve detection accuracy, as compared with such a case that an anti-theft dedicated ECU is provided at later

time.

[0116]

Also, according to the invention of claim 10, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can eliminate a high-frequency noise component (high-frequency component due to vibration which is different from inclination due to jack-up and electromagnetic noise and so on) which acts as a drag on the occasion of judging the theft state (concretely speaking, inclination or vibration) of a vehicle, and can judge the theft state of a vehicle with a high degree of accuracy.

[0117]

Also, according to the invention of claim 11, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can simply eliminate a high-frequency noise component, by switching of so-called low-pass and high-pass filter circuits.

[0118]

Also, according to the invention of claim 12, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can simply eliminate a high-frequency noise component, without using a filter circuit.

[0119]

Also, according to the invention of claim 13, achieved is such an advantage that it is possible to obtain an anti-theft

apparatus which can simply and surely eliminate a high-frequency noise component, by a simultaneous use of a filter circuit and periodical integration.

[0120]

Also, according to the invention of claim 14, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can surely detect the theft state (concretely speaking, inclination or vibration) of a vehicle, in addition to effectively using power of a battery or dry battery.

[0121]

Also, according to the invention of claim 15, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can more reduce consumption of a battery or dry battery, and can more effectively use power of a battery or dry battery.

[0122]

Also, according to the invention of claim 16, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can urgently avoid consumption of a battery or dry battery, and secure power to a portion which is indispensable for a vehicle.

[0123]

Also, according to the invention of claim 17, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can properly send out an anti-theft instruction

according to such a state that a vehicle is parked and so on, and can switch detection sensitivity at appropriate timing.

[0124]

Also, according to the invention of claim 18, achieved is such an advantage that it is possible to obtain an anti-theft apparatus which can automatically send out an anti-theft instruction, assuming that an OFF state of an ignition key is deemed to represent that vehicle is parked, and can switch detection sensitivity always at appropriate timing, without necessity of a special operation for anti-theft by a driver.

[0125]

Also, according to the invention of claim 19, achieved is such an advantage that it is possible to obtain an anti-theft method which can surely detect the theft state of a vehicle, even in case that various acceleration sensors which are mounted on a vehicle from an application other than anti-theft are also used as anti-theft.

[0126]

Also, according to the invention of claim 20, achieved is such an advantage that it is possible to obtain an anti-theft program which can surely detect the theft state of a vehicle, even in case that various acceleration sensors which are mounted on a vehicle from an application other than anti-theft are also used as anti-theft.

[Brief Description of the Drawings]

[Fig.1]

is a view showing a functional conceptual schematic structure of an anti-theft apparatus which relates to a first embodiment.

[Fig.2]

is a view for illustrating detection sensitivity of an acceleration sensor which is mounted on a vehicle.

[Fig.3]

is a block diagram showing a structure of the anti-theft apparatus which relates to the first embodiment.

[Fig.4]

is a view showing a structure of a peripheral circuit of the acceleration sensor.

[Fig.5]

is a view for illustrating detection sensitivity switching and filter switching.

[Fig.6]

is a flow chart showing process procedures of the anti-theft apparatus which relates to the first embodiment.

[Description of Reference Numerals]

10 air bag ECU

11 acceleration sensor

11a X direction acceleration sensor

11b Y direction acceleration sensor

12 CPU

13 backup power source

14 ASIC

15 SQUIB

16 gain switching part

16a X direction gain switching part

16b Y direction gain switching part

17 filter switching part

17a X direction filter switching part

17b Y direction filter switching part

18 power supply control part

18a power supply control part SW

18b power supply control part SW

18c 5V power source

18d boosting power source

19 IG key monitor

20 anti-theft ECU

21 inclination judgment part

22 alarm part

22a emergency notification transmission antenna

22b siren

22c lamp

22d head lamp

23 5V power source

24 security receiving antenna

25 receiving circuit

26 transmission circuit

27 output TR

30 battery

40 IG key SW

OIPE IAP45 MAR 0 9 2006 PATENT & TRADEMARK OFFICE

FIG. 1

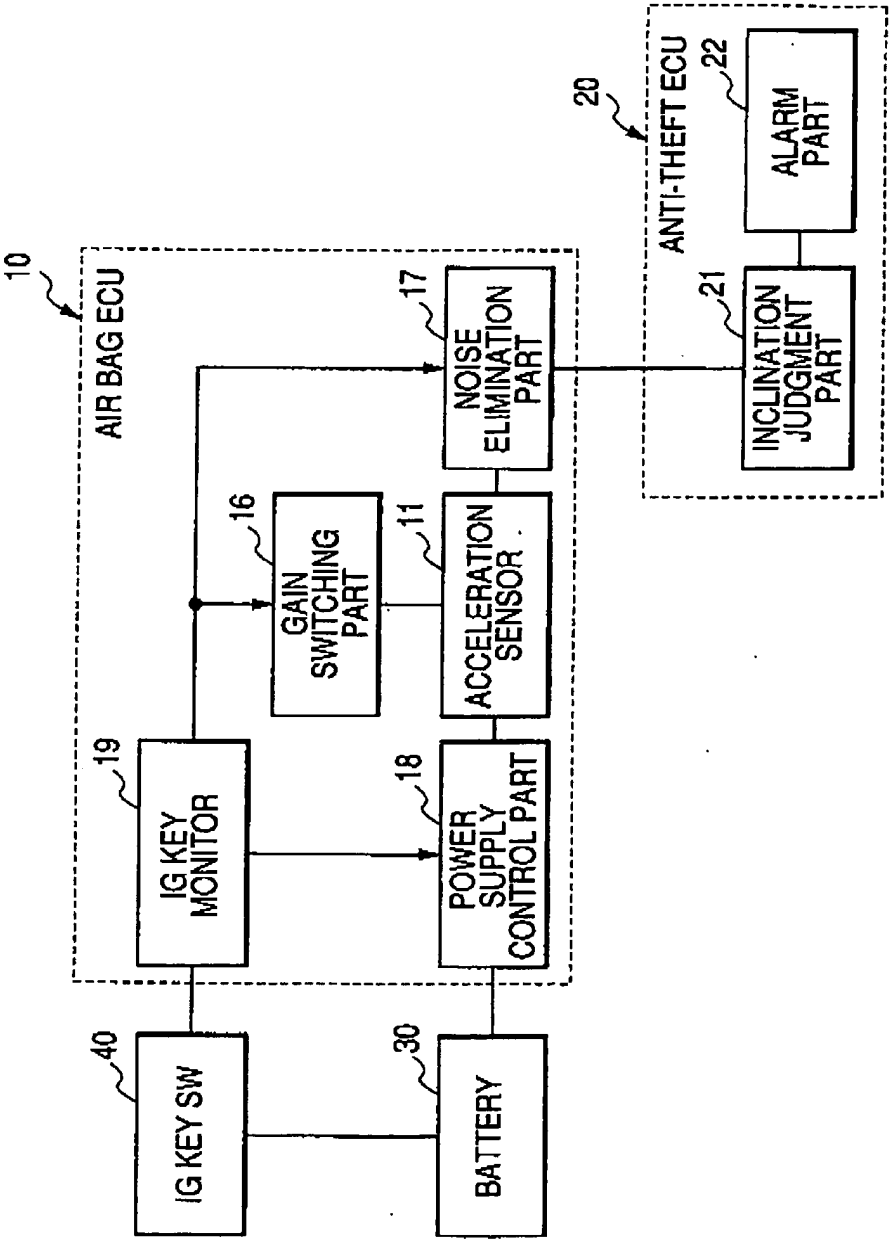


FIG. 2A

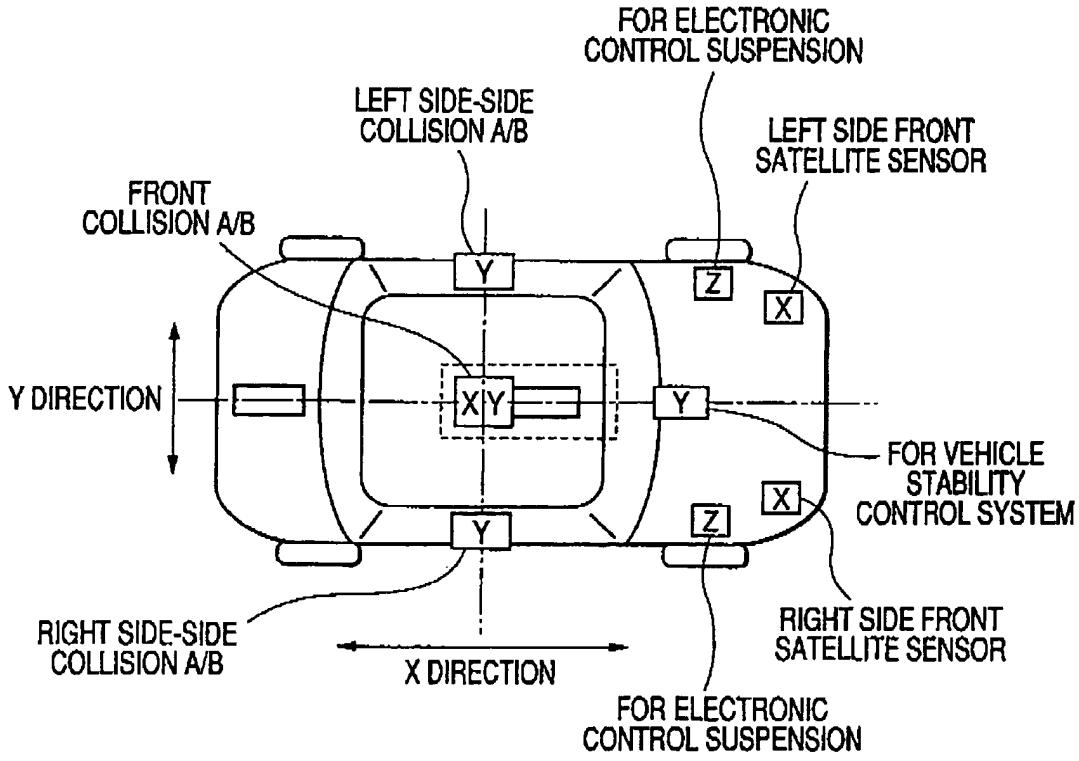
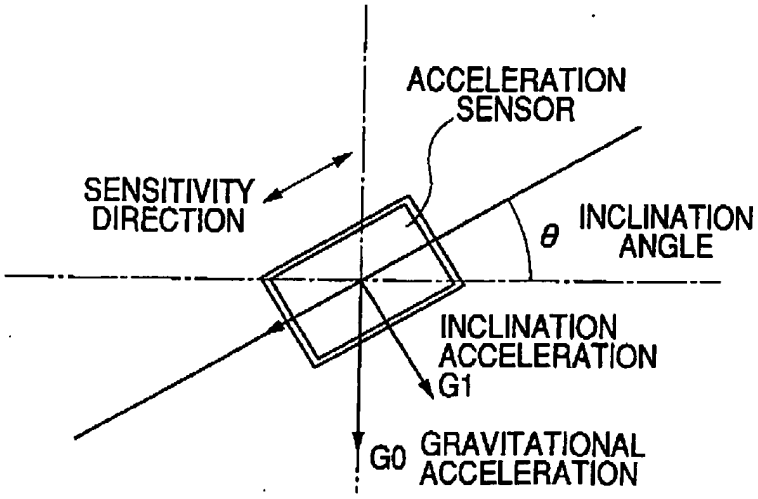

FOR ELECTRONIC CONTROL SUSPENSION
LEFT SIDE-SIDE COLLISION A/B
LEFT SIDE FRONT SATELLITE SENSOR
FRONT COLLISION A/B
Y DIRECTION
FOR VEHICLE STABILITY CONTROL SYSTEM
RIGHT SIDE-SIDE COLLISION A/B
X DIRECTION
RIGHT SIDE FRONT SATELLITE SENSOR
FOR ELECTRONIC CONTROL SUSPENSION

FIG. 2B



(ACCELERATION SENSOR OUTPUT = G0 * COS (90-θ)
LIFT AMOUNT = VEHICLE WIDTH * SIN θ)

FIG. 2C

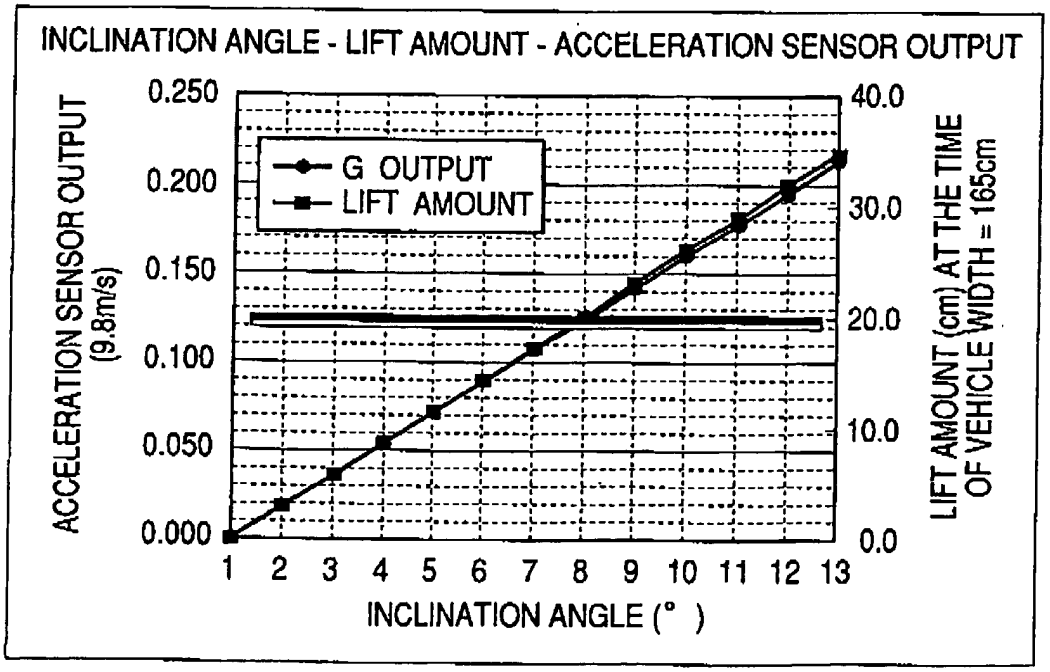


FIG. 3

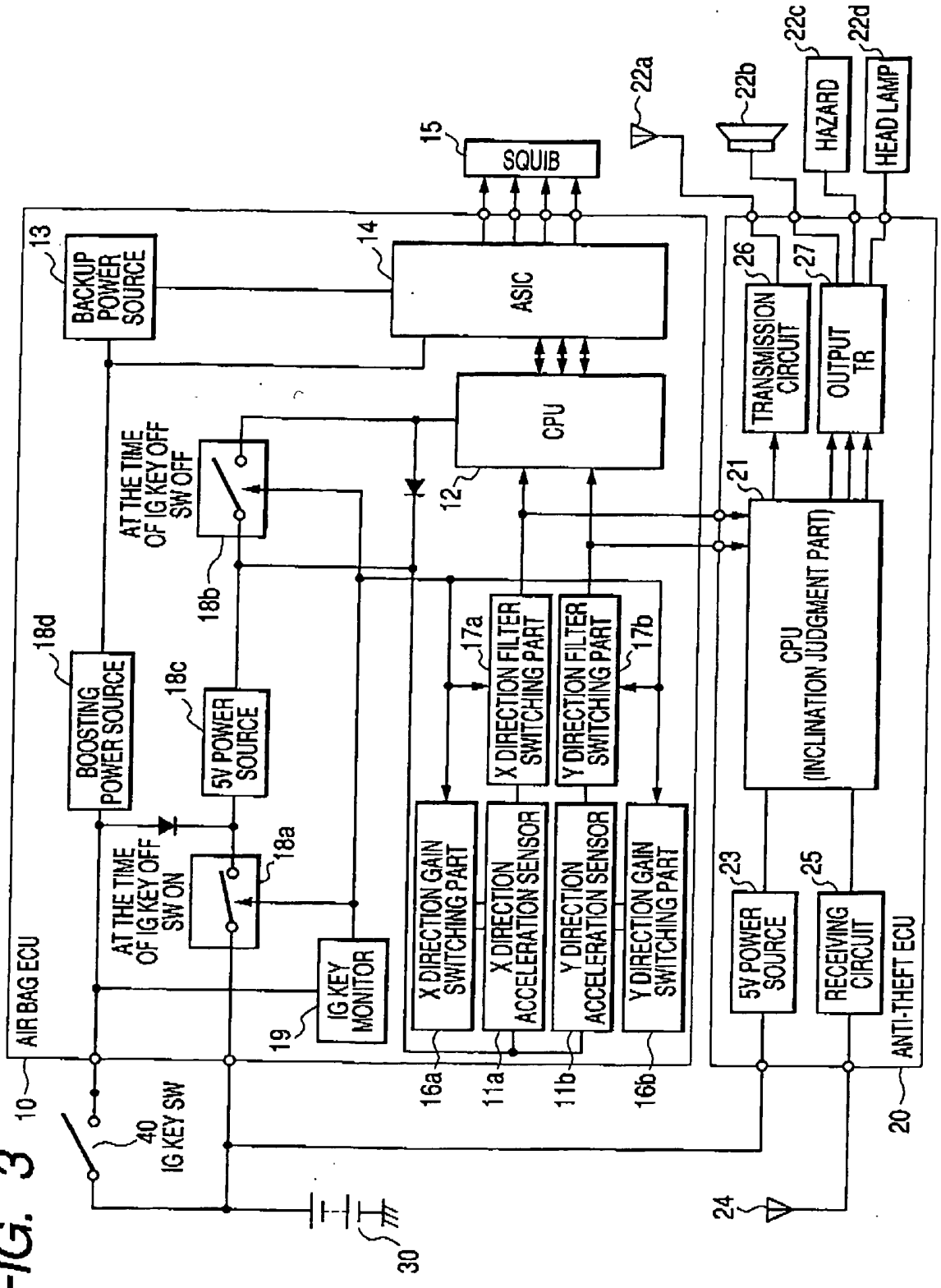

AIR BAG ECU
ANTI-THEFT ECU
BACKUP POWER SOURCE
BOOSTING POWER SOURCE
5V POWER SOURCE
ASIC
CPU
CPU (INCLINATION JUDGMENT PART)
SQUIB
AT THE TIME OF IG KEY OFF SW OFF
AT THE TIME OF IG KEY OFF SW ON
IG KEY MONITOR
IG KEY SW
X DIRECTION GAIN SWITCHING PART
X DIRECTION ACCELERATION SENSOR
X DIRECTION FILTER SWITCHING PART
Y DIRECTION FILTER SWITCHING PART
Y DIRECTION ACCELERATION SENSOR
Y DIRECTION GAIN SWITCHING PART
TRANSMISSION CIRCUIT
OUTPUT TR
5V POWER SOURCE
RECEIVING CIRCUIT
HAZARD
HEAD LAMP
10
11a
11b
12
13
14
15
16a
16b
17a
17b
18a
18b
18c
18d
19
20
21
22a
22b
22c
22d
23
24
25
26
27
30
40

FIG. 4

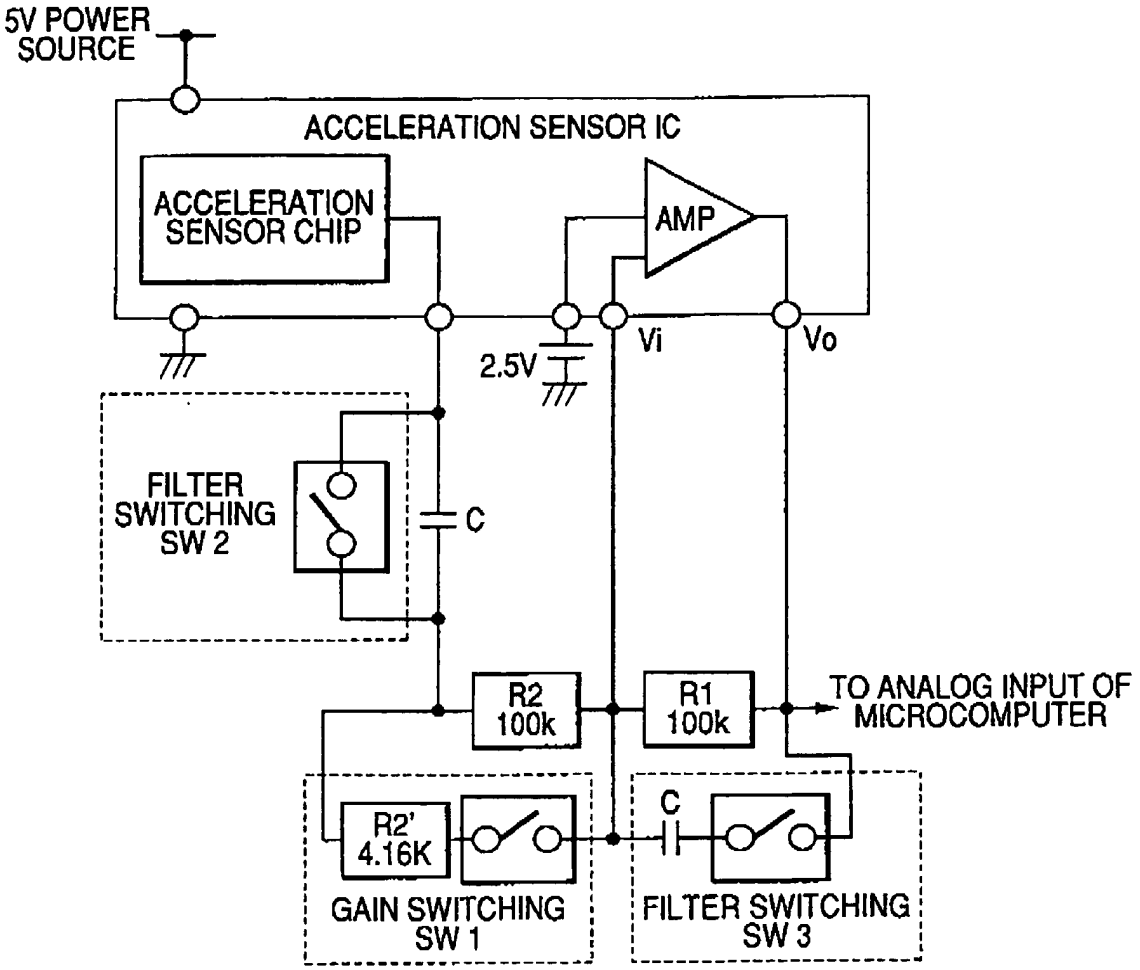

5V POWER SOURCE
ACCELERATION SENSOR IC
ACCELERATION SENSOR CHIP
AMP
Vi
Vo
2.5V
FILTER SWITCHING SW 2
C
R2 100k
R1 100k
TO ANALOG INPUT OF MICROCOMPUTER
R2' 4.16K
GAIN SWITCHING SW 1
C
FILTER SWITCHING SW 3

FIG. 5A

IG KEY	GAIN SWITCHING SW 1	FILTER SWITCHING SW 2	FILTER SWITCHING SW 3	GAIN	CUTOFF FREQUENCY
ON	OFF	OFF	OFF	±50G	200Hz
OFF	ON	ON	ON	±2G	50Hz

FIG. 5B

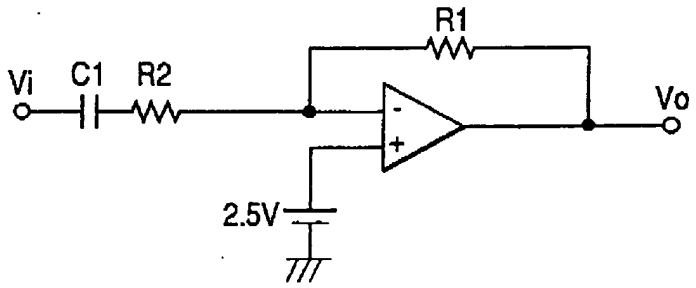


FIG. 5C

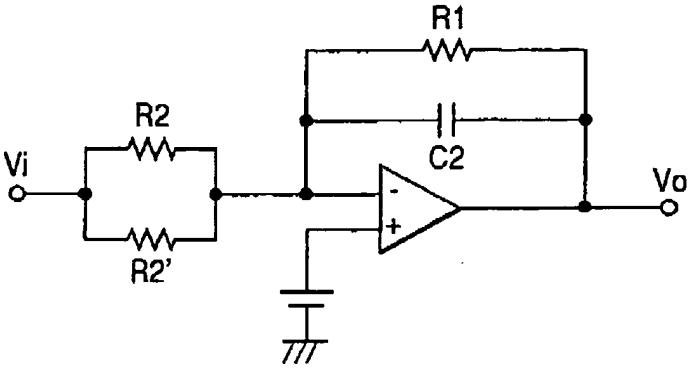
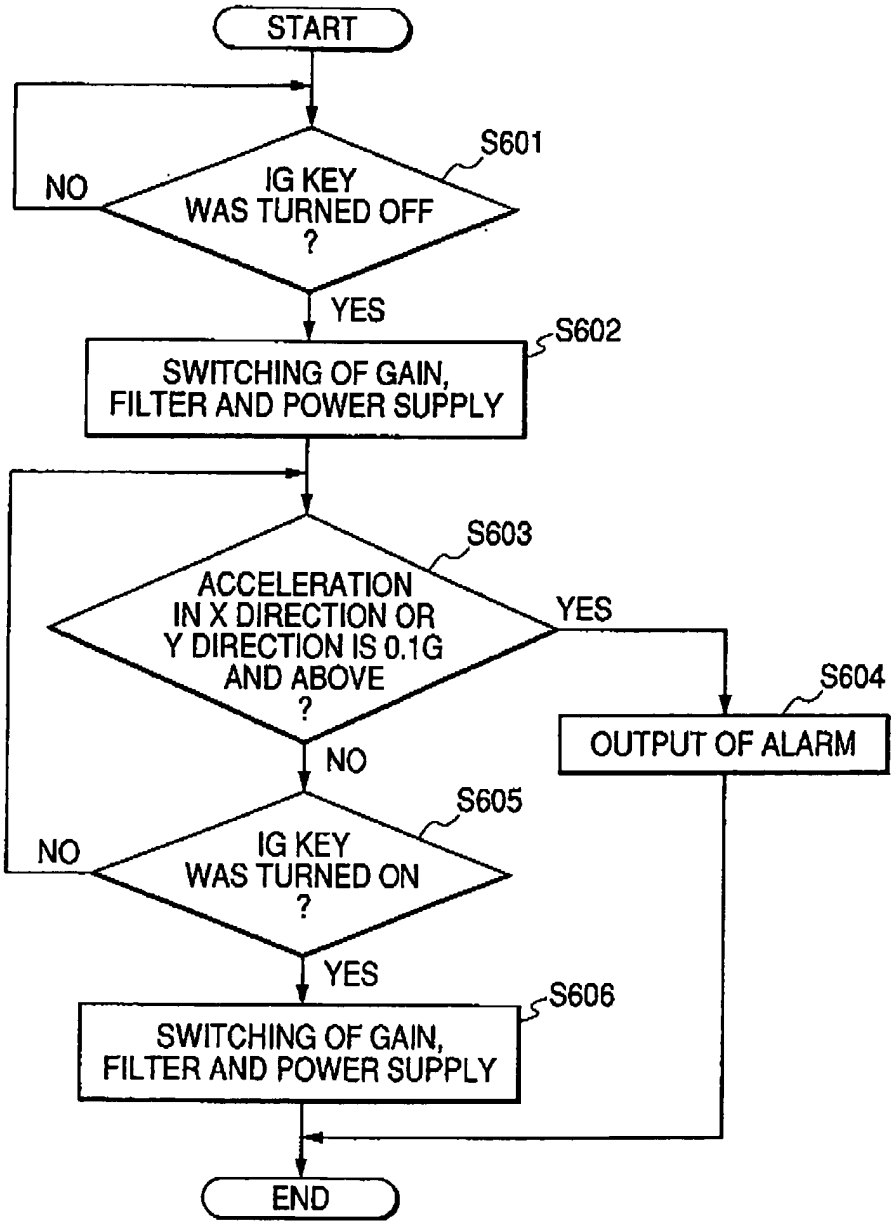


FIG. 6


START
S601
IG KEY WAS TURNED OFF ?
NO
YES
S602
SWITCHING OF GAIN, FILTER AND POWER SUPPLY
S603
ACCELERATION IN X DIRECTION OR Y DIRECTION IS 0.1G AND ABOVE ?
YES
S604
OUTPUT OF ALARM
NO
S605
IG KEY WAS TURNED ON ?
NO
YES
S606
SWITCHING OF GAIN, FILTER AND POWER SUPPLY
END

[Designation of Document] ABSTRACT

[Problem] To surely detect a theft state of a vehicle, such as inclination and vibration of a vehicle due to a theft action, even in case that various acceleration sensors, which are mounted on a vehicle for an application other than anti-theft, are used also for anti-theft.

[Solution means] An IG key monitor 19 sends out an anti-theft instruction to a GAIN switching part 16, in case that an IG key SW (ignition key switch) 40 was turned to an OFF state. The GAIN switching part 16 receives the anti-theft instruction from the IG key monitor 19, and then, switches detection sensitivity of an acceleration sensor 11 to second detection sensitivity (which is detection sensitivity available for inclination judgment of a vehicle, and for example, is approximately ±2G). An inclination judgment part 21 judges whether or not a vehicle is inclined on the basis of a detection result of the acceleration sensor 11 whose detection sensitivity was switched as described above, and outputs an anti-theft alarm through an alarm part 22, in case that an output of the acceleration sensor 11 exceeds 0.1G.

[Selected drawing] FIG. 1

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